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THE RELATIONSHIP BETWEEN PERFORMANCES ON EXAMINATIONS AND EMOTIONAL RESPONSES

A PART OF A DISSERTATION SUBMITTED TO THE FACULTY OF THE DIVISION OF THE SOCIAL SCIENCES IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATION
1940

By
WILLIAM H. WAITE

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THE RELATIONSHIP BETWEEN PERFORMANCES ON EXAMINATIONS AND EMOTIONAL RESPONSES

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Introduction

Much attention has recently been given to the analysis of emotions in the great variety of situations in which emotional responses may be expected to occur. It is known that emotions, in general, cause hyperactive or hypoactive physiological reactions at the periphery of the body. These physiological changes afford additional convenient indices of certain aspects of human reaction and temperament, for it is thought that they may indicate how much a person is moved by his thoughts and feelings.

Numerous studies have been made of these physiological changes in breathing, pulse rate, galvanic skin reflex, and blood pressure under many types of stimulating conditions. These studies at first included the simultaneous observation of only one or two of these functions. The impossibility of making accurate comparisons of physiological changes where one kind of stimulus was used in studying one function and an entirely different kind of stimulus was used with the other resulted in further developments. Where no consideration was given to the type of stimulus or to the method of recording or treating the data, there were few significant and consistent findings. More comprehensive studies followed in which a large number of these physiological responses were recorded simultaneously during the application of standard stimuli. Laboratory apparatus also became standardized.

However, the criticism can be raised that the production of emotional reaction in an experimental laboratory is artificial and that the emotion, thus induced, cannot be designated as a genuine reaction. Moreover, the subject knows that emotion-producing stimuli are to be applied, and this anticipatory mental attitude tends to keep the attention of the subject upon himself while submitting to heroic and unusual measures.

The present study aims to overcome these objections by furnishing a stimulating situation that is more natural and genuine. During the examination situation the attention of the subject is diverted from himself, the apparatus, and the laboratory situation to the immediate results of his efforts upon the examination. A second important technique has been introduced into this study. Past experiments on the effects of examinations on physiological responses indicate that the measurements were made either before or after the examination or both. In the present experiment, by means of continuous records, a number of bodily changes were measured throughout the examination. This method gives to the investigator the important advantage of identifying the records of each physiological response with the corresponding part of the examination. Therefore, the physiological effects of mental attitudes during the experiment can be more readily classified and studied.

The measurement of physiological changes that accompany emotions or feelings has occupied the attention of a large number of individuals. As a result, numerous physiological measures have been developed. Among these measures are the pulse rate, the changes in blood pressure, the galvanic skin reflex, and changes in bodily resistance, the red and white corpuscle counts, the urine analysis for nitrogen, the fluctuations in the rate and the volume of respiration and the inspiration-expiration ratios, the postural changes, the hydrogen ion concentration of saliva, and the secretions of endocrine glands and peristalsis. This is a fairly representative but by no means a complete list. From this rather extensive list of measures have been selected those that have been used most extensively and which, for the purpose of this experiment, gave promise of the best results. A preliminary study and a careful review of the literature in the field led to a selection of three physiological measures. First, a continuous breathing record was obtained. From this record was secured the rate of respiration.

Second, a continuous record of the blood pressure furnished the pulse rate and blood pressure changes. Similarly, a continuous record of the galvanic skin reflex showed changes in bodily resistance and galvanic skin deflections.

The Apparatus and Interpretation

The physiological responses observed and recorded in the present experiment were: the level of resistance (palmar), the galvanic skin reflex, the pulse rate and blood pressure, and the respiration. The apparatus for recording these physiological changes consisted of a chair with a tablet arm inclined backward at an angle of approximately thirty degrees and equipped with a special leg rest for the left leg; and a Behavior Research Photopolygraph. The photopolygraph consisted of three types of recording apparatus for the determination of blood pressure and pulse rate changes, respiration changes, changes in the level of resistance, and galvanic skin reflex.

During the experiment the resistance and the galvanic skin reflex were recorded by a Behavior Research resistance box consisting of a Wheatstone bridge. One of the electrodes completing the circuit is a zinc disk 5/8" in diameter. This is rendered relatively nonpolarizable by covering it with a paste of kaolin (china clay) and a physiological solution (.9/10 per cent concentration) of zinc sulphate. These are enclosed in a bakelite cup with only the moist kaolin touching the subject's skin. This active electrode is applied to the palm of the left hand in the case of right-handed subjects and to the palm of the right hand for left-handed subjects. The second and indifferent electrode is oval in shape and of sheet zinc. It is two and one-half inches in width and three inches in length. The forearm to which the electrode is attached is vigorously massaged with Cambridge electrode jelly to reduce skin polarization. The contact surface of the electrode is also covered with a thin layer of the same substance.

Records of respiration are obtained by means of a thoracic pneumograph of a diaphramatic type, connected by a rubber tube with a Marey tambour. Inspiration changes the air pressure in the pneumograph and this change is transmitted through the rubber tube to the Marey tambour, which transmits the respiratory movements to the aluminum wire where it is recorded on the sensitized paper by means of shadow writing. The measurement of the rate of breathing is made on the breathing line. The rate of breathing is secured by a count of the number of peaks occurring in the breathing line during minute intervals. These are judged solely by inspection.

The pulse rate and blood pressure changes are obtained by using a continuous polygraphic method of recording. The heart rate is counted from the number of peaks caused by heart pulsations appearing on the blood pressure line. Measurement is made during every minute interval, a distance of eight and one-half millimeters upon the sensitized paper.

The frequency of these blood pressure fluctuations is calculated by the number of "waves" appearing on the blood pressure line during minute intervals. To be considered significant, a fluctuation in blood pressure had to be well rounded in shape and had to have an amplitude of at least one millimeter measured from the immediately preceding base line. The measurement of the amplitude of the fluctuation is secured by calculating in millimeters the distance from the fixed base line immediately preceding the rise to the maximum height of each peak. The duration of the fluctuation is measured from a preceding horizontal section to a following horizontal section or a return to the normal base line.

Procedure

The data of the present study were obtained from sixty boys of the University of Chicago High School. All of the subjects volunteered to participate in the experiment after the nature of the experiment had been explained to them.

On each of the subjects used, separate readings for each physiological function were obtained on three different occasions. The subjects were scheduled to report once a week on the same day and at the same time for three successive weeks. One-half hour was assigned to each subject. Twelve subjects were examined every day, sixty subjects a week.

Upon the subject's first entry into the laboratory a carefully planned attempt was made to put him at his ease and hasten adaptation. The method and ultimate purpose of

the experiment were explained to him. He was allowed to inspect the apparatus and to ask any questions that suggested themselves. After a desirable social relationship had been established, the subject was requested to sit in the reclining chair and to place his left leg along the special support. The trouser leg was rolled up and the pressure cuff applied just above the left ankle. A special foot rest help to eliminate any turning of the leg. The electrodes were then attached to the palm and forearm. The hand was then placed in the lap in a restful position. The subject was instructed to avoid all movement of the hand and fingers, if possible. The pneumograph was fastened around the chest by a leather belt and buckle. Subjects were instructed to wear the same type of clothing during their three visits to the laboratory, to notice particularly the position of the pneumograph on the chest, and to remember how it felt in order to assist the investigator in placing it.

After the apparatus had been attached, the electric motor which drove the film was started with the drive shaft out of gear. Moreover, the subject was placed with his back to the apparatus. As a further precaution a screen shut off from the subject's view all of the recording apparatus. This procedure prevented the subject from knowing when the actual recording was taking place and yet permitted the investigator to detect any movement on the part of the subject that might affect the records.

The subjects were instructed to remain as quiet as possible for a period of about ten minutes. They were warned not to fall asleep. After the apparatus was adjusted so that all parts were working satisfactorily, a five minute record was made. The purpose of this record was to secure the subjects' emotional reaction on their first visit to the laboratory.

The following week the subjects appeared for the second time at the laboratory. After the apparatus was adjusted and the motor started, the subjects were required to engage in simple cross-out exercises. The purpose of these exercises was to secure a condition somewhat comparable with the physical activities of a written examination situation. The subjects were advised that the exercises were of no particular consequence except for the purposes of concentration. A fifteen minute record was made during the second trial.

On the subjects' third visit to the laboratory, a written examination was substituted for the cross-out exercise. The examination consisted of three parts: number series, word completion, and artificial language, consisting of twenty questions, forty sentences, and twenty sentences respectively. The following instructions were given before the examination: "This is an examination of speed and accuracy. The results of this examination will determine your rank in a group of sixty boys. One copy of the results will be handed to your principal; another copy will be posted on the high school bulletin board. The examination consists of three parts, and you will have five minutes for each part. The first part is one page in length, the second and third parts, two pages in length. Do not begin until you receive the signal, 'ready, go.' You will be warned when only one minute remains in each part. When time is called, go to the next part. You are not expected to finish but answer as many questions as you can." This procedure was later adhered to during the conduct of the examination.

Since the same examination was given to subjects at various times of the day and on different days of the week, the subjects were pledged to refrain from discussing the nature of the questions with any other subject either before or after the examination. Each subject was interviewed immediately before the examination and, as far as could be ascertained, there was no collaboration among the subjects.

Although the examination was not based on accomplishment in academic subjects, every attempt was made to produce a natural and genuine examination situation. Some of the subjects were attending high school on scholarships and had scholastic prestige to maintain. Among the subjects, in general, scholarship was held at a high premium and competition was therefore very keen.

Variations in Physiological Responses During the Initial, Control, and Experimental Periods

The data for this part of the study were secured from the record sheets of sixty subjects.

The means of the raw scores during successive minutes of observation are calculated to show the general trends and levels of re-

sponse for each physiological measurement. The average score for the experimental period was higher than the corresponding average during the control period. This is true for each of the types of measures secured. In the case of log conductance, frequency of galvanic skin reflex, heart rate, respiration rate, and amplitude of fluctuations in blood pressure, the difference between the control and experimental periods in Table I is seen to be statistically significant.

A second general observation made from the graphs is that the scores during the experimental period show greater variability than those during the control period. It may be noted in addition that, except for the measure of the heart rate, the average scores during the initial period were above those for the corresponding minutes of the control period.

An examination of the individual types of measures shows some interesting results. For example, in log conductance the initial and control period records reveal that there is, under usual conditions, a gradual decrease in log conductance during the early minutes of a period of observations, followed by a gradual and regular increase that is maintained at least through the fifteenth minute. Beyond this period of time our observations did not extend. We find, in contrast to this picture during the experimental period, a regular pattern of increase and decrease in scores directly related to the five minute periods into which the examination was divided. After a high initial score, the experimental period displays a dropping off until the third minute. This decrease is followed by a sharp rise to the end of the sixth minute. After the sixth minute there is again a falling off followed by another rise to the tenth minute. This pattern repeats itself still again following the tenth minute. Thus, during this experimental trial there appears a definite pattern characterized first by a decrease, which is followed by a marked increase in conductance toward the end of each five minute period.

There was a general increased level of log conductance for each successive five minute period, the average log conductance for successive five minute periods being 133.92, 139.97, and 145.22. As was mentioned in the general observations, the level of log conductance during the experimental period was much greater than during the control period.

In general, the frequency of the galvanic skin reflex shows results similar to those for log conductance. There is, however, during the initial and control trials, no obvious tendency to a progressively lower score for the initial minutes of observation. The scores seem to increase fairly regularly and gradually throughout the period of observation. The initial minute of the experimental period is unusually high in score. This high score is

TABLE I

AVERAGE SCORE FOR THE VARIOUS CONDITIONS WITH THEIR STANDARD ERRORS AND THE CRITICAL RATIO FOR THE DIFFERENCE BETWEEN THE EXPERIMENTAL AND CONTROL PERIODS

Measurement	Initial Period	Control Period	Experimental Period	Difference between Control and Experimental periods.	Standard Error of difference	Critical Ratio of difference between Control and Experimental periods.
Log Conductance	134.76 ± 1.63	124.21 ± .91	139.70 ± .84	15.49	1.24	12.49
Frequency of Galvanic Skin Reflex	5.04 ± .29	3.93 ± .15	6.56 ± .14	2.63	.21	12.52
Respiration Rate	19.55 ± .18	19.22 ± .11	20.82 ± .10	1.60	.15	10.67
Heart Rate	80.60 ± .72	80.99 ± .37	85.15 ± .44	4.16	.58	7.17
Frequency of Fluctuations in Blood Pressure	.84 ± .09	.20 ± .03	.30 ± .03	.10	.04	2.50
Amplitude of Fluctuations in Blood Pressure	.36 ± .01	.08 ± .01	.14 ± .01	.06	.01	6.00
Duration of Fluctuations in Blood Pressure	2.53 ± .23	.64 ± .08	.88 ± .09	.24	.12	2.00

followed by a sharp decline during the following minute. At the fourth minute an emphatic increase is initiated, which lasts to the sixth minute. A sharp decline again occurs, and this decline in turn is followed by a pronounced increase to the tenth minute. A third decrease then takes place, followed by a marked increase to the end of the period. There is again a pattern of response clearly correlated with successive five minute examination periods. The average level of response, of course, is much higher for the experimental period and the general pattern is more irregular. As with log conductance, the averages for successive five minute periods of the experimental trial show a progressive increase, being 5.78, 6.72, and 7.18 respectively.

The scores in the rate of respiration in the initial and control trials show a general tendency to drop progressively during successive minutes of observation. During the experimental period a very marked difference is evident. The average score of 20.82 is noticeably higher than the general levels of the initial and control groups, and although during the first eleven minutes of the period there is an irregular decrease in rate, this is followed by a marked increase. During the last four minutes the breathing rate returns almost to the initial level of respiration for that trial. The presence of the examination seems to have produced a significant acceleration in the rate of breathing.

The data for the heart rate of the initial and control periods show a general tendency for the rate to increase progressively during the periods of observation. The heart rate during the experimental period shows considerable irregularity. The general level of response, determined by the average of the means, is much higher than in the case of the initial and control periods. A decrease during the second minute is followed by an increase, which is maintained to the fifth minute. A second and extensive decrease takes place, which is followed by an increase to the end of the ninth minute. A third and very slight decrease to the eleventh minute is followed by a rise, which is maintained to the fourteenth minute. The beginning of each part of the examination appears to be accompanied by a general retardation of the heart rate, followed by a gradual recovery and acceleration.

The frequency, amplitude, and duration of fluctuations in blood pressure show a very high level of response during the initial period. In contrast, the levels of responses during the control period are much lower. These responses for the experimental period are slightly higher than for the control period and show marked irregularity throughout. There is an observable similarity of pattern for the three measures in the experimental period.

The Effects of Successful, Average, and Unsuccessful Effort During a Short Period of Time on Certain Physiological Responses

Research relative to the general problem of the effects of examination difficulty on physiological responses has not been extensive and has in the main limited itself almost entirely to the measurement of physiological variations before and after the examination. However, experienced difficulty is a variable quantity that may express itself in varying degrees of intensity during the course of any one examination as the pupil interprets his chances of success or failure from the answers he makes. Moreover, it is possible to differentiate individuals who have taken an examination, on the basis of their performance as evidenced by their score on it. It then seems likely that those characterized by successful performance would have some awareness of their success, and conversely that those with poor performance would likewise have some knowledge of their difficulty. In order to get at the possible effects of such knowledge upon the physiological functions studied in this investigation, additional analyses of the data were made as described below.

As shown earlier, the examination was divided into three parts of five minute duration, and the physiological responses of the subject were secured during the writing of each part. The twelve best scores, the twelve average scores, and the twelve worst scores were then selected from each of the three parts and the corresponding concomitant physiological responses compared. By this approach an attempt was made to determine the effects of slight difficulty, average difficulty, and extreme difficulty upon the general trend of the physiological responses during a five minute period.

The graphs of log conductance show relative similarity in form both from period to period and from one type of performance to another. In each case the scores in general show a marked decrease during the initial part of the period, followed by an equally conspicuous rise to the end of the period. In the first period those who did best had, in general, a lower level of response in log conductance, while in the third period those making average scores show a lower level of response than those making the best or worst scores. A possible explanation of the lower level of response in the first period, for those making the best scores, might be a relatively high degree of self-confidence at the beginning of the examination period, while the difference found in the third period may perhaps be accounted for by greater indifference to the situation on the part of those making average scores. Those pupils making the best scores possibly were by then highly motivated by success, while those who made the worst scores were emotionally upset by the difficulty.

In the case of the scores of the frequency of galvanic skin reflex, the average group in the third period again shows a relatively low level of response. As already stated for log conductance, this low level of response may be due to the apparent indifference of the average group to the general situation.

In contrast to the results for log conductance and the galvanic skin reflex, there appear to be significant differences between those who made the best, average, and worst scores as indicated by the progressive changes in the rate of respiration. There appears to be a tendency for the rate of respiration to increase from period to period in the case of those making the best scores, to remain relatively constant in the case of those making the average scores, and for those making the worst scores to become progressively lower. This might be interpreted to mean that subjects who experienced success are more highly motivated and breathe more rapidly. Those who make average scores may be relatively stable and indifferent to the examination situation, and those students who make the worst score may experience a "blocking" that is reflected in the respiration rate.

In comparison with the other groups, those making the best scores appear to have a higher initial heart rate and to maintain a higher rate level throughout the respective examination periods. This is most marked, however, in the middle period. For the corresponding period of those making average scores, there is a much lower level of response, while the period for those making the worst scores has the lowest level of all.

The only significant difference in the graphs on the frequency, amplitude, and duration of fluctuations in blood pressure seems to be a relatively high level of response for those making the worst scores during the third period. We also find some tendency for the average scores to be lower throughout the three periods. In the duration of fluctuations, the best scores show a slightly higher level in the first period than either of the others. Irregularities and inconsistencies in the graphs for the blood pressure measurements render it difficult to make further observations.

The Effects of Continued Successful, Average, and Unsuccessful Effort on Certain Physiological Responses

The purpose of this part of the study is to examine and compare certain physiological responses accompanying continued success, continued average performance, and continued failure for the examination as a whole. As stated before, the examination was divided into three parts, and the physiological responses were obtained during the writing of each part. The best scores are the scores of the twelve subjects who made the highest marks on the three parts of the examination. Similarly, the average scores are the scores of the twelve subjects who made average marks on the three parts of the examination, and the worst scores are those of the twelve subjects who consistently made the lowest marks on the three parts of the examination.

A general characteristic of the graphs of log conductance is their relative similarity, with the exception that the average scores show very little of the usual pattern of change during the middle five minute period. Otherwise, the scores show a marked decrease during the earlier part of the period followed by rises at the sixth, tenth, and fifteenth minute. The average scores show a lower level of response than either the best or the worst scores. There is little difference in the behavior patterns of the levels of response

between pupils making the best and worst scores.

In the frequency of the galvanic skin reflex there appear to be no distinguishing characteristics between pupils making the best, average, and worst scores. The graphs have approximately the same initial level of response and are extremely irregular. All of the graphs show the common characteristic of marked increases at the sixth, tenth, and approximately the fifteenth minute.

In the breathing rate, however, significant differences between the three groups appear. Those making the worst scores have a low initial response and a gradual and regular decline until the thirteenth minute, from which point a partial recovery is made. The best and average scores show a high initial response. A gradual decline also takes place with a partial recovery occurring at the beginning of the thirteenth minute.

There are marked differences in the heart rates of those making the best, average, and worst scores. The general level of response for those making the best scores is extremely high and remains fairly constant as such throughout the fifteen minutes. The highest points on the graph occur at the fifth, tenth, and fourteenth minute. The level of response for the average scores is observably lower than for the best scores. The responses are more irregular than in the case of the other two classifications. Near the end of the period, the average scores become relatively stable and finish with a fairly high level of response. In the case of those making the worst scores, there is a lower level of response than is found in the other two types of scores. The trend is relatively stable.

The graphs of the frequency, amplitude, and duration of fluctuations in blood pressure are so irregular that they preclude significant observations. The frequency of fluctuations in the best scores shows a lower level of response and a more stable tendency than either of the other two measurements. In all three sets of graphs, the average and worst scores show a slight tendency toward a progressive decline, which is not shown by the graphs of the best scores.

Examination Results and Physiological Responses

As shown in the foregoing results, physiological changes occur in the body during the taking of an examination. There is a direct correspondence between the pattern of physiological change and the conditions of the examination. It has also been shown that, in general, those successful in the examination manifest an acceleration of some of the measurements of the physiological responses. In the section to follow, the physiological responses recorded during the writing of the examination are correlated with the examination marks to determine to what extent the quantitative results of the examination and the types of response expressed by the subjects are related. Table II indicates the amount of relationship between the two types of measures.

An inspection of Table II indicates that seven factors show positive correlation and four factors show negative correlation. In no case are their values sufficiently large to justify their use for suggestive relationship or predictive purposes. The largest coefficient is +.23, the correlation between the mean heart rate and success on the examination.

A further approach is made to the problem by relating the difference of the control and experimental means to the examination grades. The differences are calculated by subtracting the means of each physiological response for the control and experimental situation. The results are given in Table III.

Table II

The Relation Between Physiological Scores and Examination Grades

Physiological Responses	Coefficients of Correlation of Physiological Scores with Examination Grades
Log conductance	—.06 ± .09
Standard deviation of log conductance	+.11 ± .09
Frequency of galvanic skin reflex	+.03 ± .09
Standard deviation of galvanic skin reflex	+.11 ± .09
Heart rate	+.23 ± .08
Standard deviation of heart rate	—.05 ± .09
Frequency of fluctuations in blood pressure	+.02 ± .09
Amplitude of fluctuations in blood pressure	—.16 ± .09
Duration of fluctuations in blood pressure	—.04 ± .09
Respiration rate	+.06 ± .09
Standard deviation of respiration rate	+.08 ± .09

The data indicate that the values are again too small to be statistically significant.

In conclusion, the study failed to find any correlation either between the physiological responses recorded during the examination and the examination marks or between the physiological changes and the examination marks. However, emotional disturbances, due to the examination, are accompanied by physiological changes. The evidence also shows, in a general way, that some of the measures of the physiological responses are associated with successful and unsuccessful effort. Therefore, the lack of correlation between physiological measures and examination marks may be due to one or more of the following causes. There may be physiological changes associated with examination success that cannot be measured because of the lack of refined scientific apparatus or faulty technique. The pupils may have become so conditioned to examinations that minute individual physiological differences have become lost in the group. The examination, since it did not affect the scholastic rating of the subjects, perhaps failed to produce those physiological changes usually associated with individual success or failure.

Summary

Physiological psychologists have long recognized that beneath certain mental states of the individual, beneath such emotional reactions as anger, fear, anticipation, anxiety, disgust, etc., there are traceable definite physiological changes peculiar to the organism. However, a survey of the literature in the field shows that no previous study has attempted to take continuous records of physiological responses during the writing of examinations.

Sixty boys of the University of Chicago Laboratory Schools voluntarily agreed to participate in the experiment. Each subject visited the psychological laboratory on the same day and at the same time for three successive weeks. Physiological changes were recorded by a Behavior Research Photopolygraph consisting of three types of recording apparatus for the determination of changes in the level of resistance and the galvanic skin reflex, respiration changes, and changes in the blood pressure and pulse rate.

Three separate and distinct situations were studied: first, the initial period, the first visit of the subjects to the laboratory; second, the control period, the second visit of the subject to the laboratory a week later; and third, the experimental or examination situation.

Four types of study were undertaken. First, the effects of the initial, control, and experimental periods on the entire group of subjects and the statistical significance of the amount of change in the physiological measures between the control and experimental situation. Second, the effects of successful, average, and unsuccessful effort during a short period of time on certain physiological responses. Third, the effects of continued successful, average, and unsuccessful effort on certain physiological responses. Fourth, the relations between examination marks and physiological responses.

1. Statistically significant increases occurred during the examination period in log conductance, in the frequency of the galvanic skin reflex, in the respiration rate, in the heart rate, and in the amplitude of fluctuations in blood pressure.

2. Repetitious patterns approximately correlated with the five minute examination periods were most marked in the frequency of the galvanic skin reflex and somewhat less obvious in the measures of log conductance.

3. During the examination period, the rate of breathing was accelerated. The effect of

Table III

The Relation Between Physiological Changes and Examination Grades

Physiological Changes Control to Experimental Period	Coefficients to Correlation of Physiological Variables with Examination Grades
Log conductance	−.20 ± .08
Standard deviation of log conductance	+.06 ± .09
Frequency of galvanic skin reflex	+.17 ± .09
Standard deviation of galvanic skin reflex	+.13 ± .09
Heart rate	+.15 ± .09
Standard deviation of heart rate	+.10 ± .09
Frequency of fluctuations in blood pressure	+.04 ± .09
Amplitude of fluctuations in blood pressure	−.11 ± .09
Duration of fluctuations in blood pressure	−.05 ± .09
Respiration rate	+.07 ± .09
Standard deviation of respiration rate	−.04 ± .09

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most marked at the beginning and tended to decrease throughout most of the examination period.

4. The heart rate was very high during the first five minutes of the examination. A falling off occurred during the second five minutes, followed by a gradual recovery to the original level of response during the latter part of the examination.

5. The frequency, amplitude, and duration of fluctuations in blood pressure showed little consistency in pattern, and it is doubtful whether any conclusions may be drawn therefrom.

6. An attempt was made to discover the relation between the quality of the examination performance and the physiological responses. During a short examination period no significant differences in log conductance and the galvanic skin reflex occurred between those who made the best, average, and worst scores.

7. There was a tendency during a short examination period for the rate of respiration to increase from period to period in the case of those making the best scores, to remain relatively constant in the case of those making average scores, and to become progressively lower for those making the worst scores.

8. The measurements of the heart rate indicated that during a short examination period, those making the best scores appeared to have a higher initial heart rate and to maintain a higher rate level throughout the respective examination periods. This was most marked in the middle period. For the corresponding period of the average scores there was a much lower level of response, while that of the worst scores had the lowest level of all.

9. For those who made the best, average, and worst scores in continuous effort throughout the examination period, the outstanding differentiates were found in the breathing rate and the heart rate. In the breathing rate those making the worst scores had a low initial response and a gradual and regular decline until the thirteenth minute, from which point a partial recovery was made. The best and average scores showed a high initial response, followed by a gradual decline with a partial recovery occurring at the beginning of the thirteenth minute.

10. The general level of response for the heart rate during continued effort, for those making the best scores, was extremely high and remained fairly constant as such throughout the fifteen minutes. The level of response for those making average scores was observably lower than for the best scores, while for those making the worst scores there was a lower level of response than was found in the other two types of scores.

11. No significant correlations were found either between the physiological scores secured during the examination and the examination marks, or between the physiological changes for the control to the experimental period and the examination marks. Reasons have been advanced for this lack of relationship.

The findings of this experiment indicate that there is a general pattern of response for some physiological measures during examinations. There is also some suggestion that physiological responses of heart rate and respiration rate may be associated with success or failure on examinations of varying length, but the results are not conclusive.